APPLICATION FOR PATENT

Title: One Trip String Tensioning and Hanger Securing Method

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FIELD OF THE INVENTION

The field of this invention relates to methods for running in and tensioning a tubular string to a wellhead and more particularly where the hanger is sealed and secured in a single trip when tensioning.

BACKGROUND OF THE INVENTION

In an oil and gas well, one or more strings of casing will be cemented within the well. In one system used with offshore jack-up drilling rigs, a mudline hanger located in a subsea housing at the sea floor will support the string of casing in the well. A section of the casing will extend upward to a surface wellhead housing on the drill rig. The surface wellhead housing will be located above the sea and below the rig floor. The distance from the subsea housing to the surface wellhead could be as much as 500 feet with a large jack-up drilling rig.

Cement will be pumped down the string to flow up the annulus to cement the casing in the well. The level of cement will be below the mudline hanger. The casing will be cut off at the surface wellhead. The blowout preventer will be removed, and a spear will be used to pull tension on the casing after cementing. Then slips will be inserted around the casing, which engage the wellhead housing and grip the casing to hold the casing in tension. A packoff will be installed between the casing hanger and the wellhead housing.

A disadvantage of this system is that the blowout preventer must be removed while installing the slips and packoff. A danger of a blowout thus exists. Also, this system is time consuming and

expensive. In addition to this, the sealing mechanisms are generally elastomer or on site machined to give metal-to-metal seals.

In another design, described in U.S. Patent 5,002,131 after cementing, dogs mounted to the exterior of the casing hanger are released. Each of the dogs has a set of circumferential grooves or wickers on the exterior for engaging the wellhead housing. The wellhead housing has a mating set of grooves or wickers. Springs urge the dogs outward.

The running tool for the casing hanger has a sleeve retainer. This retainer holds the dogs in the retracted position during cementing. After cementing, rotating the running tool unscrews the running tool from the casing hanger. When this occurs, the sleeve moves upward, releasing the dogs to engage the wellhead housing.

Before the running tool completely releases, tension is applied to the casing to the desired amount. The dogs ratchet over the wickers in the wellhead housing as the casing hanger moves up while the tension is applied. The dogs grip the wellhead housing, preventing the casing hanger from moving downward. The running tool and sleeve are then removed from the wellhead housing. Thereafter, in a separate trip, a seal assembly is installed to seal the annular gap between the string and the wellhead. A similar design is disclosed in U.S Patent 5,255,746. String tensioning devices are generally illustrated in U.S. Patents 5,310,007 and 5,839,512.

The present invention seeks to overcome some of the shortcomings of the prior designs. It provides a one-trip method to apply tension to the string and to seal the hanger in the annular space. It also has capability to lock the hanger in a sealed position in the same single trip. It accordingly minimizes the time the annular space is open and improves the safety of the operation by providing the isolation capability in that same single trip. These and other advantages of the

present invention will become more apparent to those skilled in the art from a review of the description of the preferred embodiment and the claims that appear below.

SUMMARY OF THE INVENTION

A running tool delivers a string through a wellhead in the same trip as a hanger with a seal and locking assembly. The string is secured downhole and the running tool is manipulated to release a lock to hold the hanger in a sealed position in the wellhead prior to a tensile force being applied. A ratchet assembly permits the string to stretch and the tensile force is then locked in. The running tool is rotated out of the string and the tree is installed on the wellhead for subsequent procedures or production.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a section view, in elevation, of one embodiment of the running tool shown supporting a string to be inserted into a wellhead;

Figure 2 is an enlargement of the lower end of Figure 1 showing the ratchet assembly in more detail;

Figures 3A and 3B show alternative designs for the locking dog in the ratchet assembly;

Figure 4 is the assembly of Figure 1 landed in a wellhead;

Figure 5 is the view of Figure 4 after the hanger is locked and sealed in the wellhead;

Figure 6 is the view of Figure 5 showing tension being pulled on the running tool;

Figure 7 is the view of Figure 6 with the running tool removed and a tubing head adaptor installed;

Figure 8 is an alternative design to Figure 1 featuring a hydraulic piston on the running tool;

Figure 9 is the view of Figure 8 with the tubing tied back at its lower end in the wellbore;

Figure 10 is the view of Figure 9 showing tension on the string and operation of the hydraulic piston to land the hanger in the wellhead;

Figure 11 is the view of Figure 10 with the tensile force removed and the tension locked in with the ratchet and the hydraulic piston actuating the hanger into final position where it will be locked in after rotation of the running tool; and

Figure 12 is the view of Figure 11 with the running tool removed and a tubing head adaptor installed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figures 1 and 2, a string **10** is supported by a running tool **12** at thread **14**. String **10** is also secured to inner ratchet sleeve **16**, which has a groove **18** in which is disposed a dog **20**. Two different embodiments of dog **20** are shown in Figures 3A and 3B. In Figure 3A, dog **20** has two peak surfaces **22** and **24** separated by a valley surface **26**. In the Figure 3B embodiment, the dog **20** has a single sloping surface **28** adjacent a cylindrical surface **30**. Outer ratchet sleeve **32** surrounds inner ratchet sleeve **16** and seal **34** seals between them. Those skilled in the art will appreciate that seal **34** can be mounted on the inner sleeve **16** or the outer sleeve **32**. Similarly, the ratchet assembly now being described can be reversed as between these two sleeves without departing from the scope of the invention. In the preferred embodiment, outer sleeve **32** has a ratchet rack **36** defining a plurality of depressions **38** that conform in shape to peak surfaces **22** and **24** shown in Figure 3A or surfaces **28** and **30** shown in Figure 3B.Preferably, dog **20** is a split ring having a c-shape with a built in outward bias out of groove **18**. Those skilled in the art will appreciate that other forms of bias can be applied to dog **20** external to its structure and still be within the scope of the invention. As shown in Figures 1 and 2 inner sleeve **16** can move up with respect to outer sleeve **32** and dog **20** will simply jump from one depression **38** to another as its

diameter decreases to allow such movement. Relative movement in the reverse direction will be precluded by dog **20** expanding into the most adjacent depression **38** and locking the sleeves **16** and **32** to each other.

Referring again to Figure 1, outer sleeve is connected to hanger **40** at thread **42**. Seals **44** and **46** are supported on hanger **40** for sealing contact with surface **48** of wellhead **50**, as shown in Figure 4. Referring back to Figure 1, a lock retainer sleeve **52** holds in a locking ring **54** when running the string **10** into the wellhead **50**. Rotation of running tool **12** backs out thread **14** and allows sleeve **52** to rise away from locking ring **54**. When this happens, locking ring **54** can snap out into a groove **56** in wellhead **50** (see Figure 4).

The method proceeds as follows. The running tool **12** supports the string **10** as well as the hanger **40** and the sleeve **52** in a position where it is retaining the locking ring **54** in a retracted position. Initially, the string **10** is tagged downhole to a seal bore or packer (not shown). In any event, the lower end of string **10** is secured downhole. A shoulder **58** on hanger **40** (see Figure 1) is landed on a shoulder **60** in wellhead **50**. This is the position in Figure 4.

In Figure 5, the running tool **12** is rotated to back out thread **14** and raise sleeve **52** away from locking ring **54** to allow it to snap out into groove **56**. The hanger **40** is thus locked to the wellhead **50** and seals **44** and **46** seal between the two.

In Figure 6, thread **14** is still engaged so that an upward pull on the running tool **12** puts tension on string **10** while inner sleeve **16** moves up with string **10** as the tension is being applied. Dog **20** skips along ratchet rack **36**. Outer sleeve **32** is stationary at this time because the hanger **40** is secured to wellhead **50** by locking ring **54** and outer sleeve **32** is secured to hanger **40** at thread **42**. After the appropriate tension is pulled on the running tool **12** the pulling force is removed. Groove **18** with dog **20** move down until dog **20** can spring out into a depression **38**. At that point

the one trip procedure is concluded. The necessary tension is on the string **10** and hanger **40** is locked to wellhead **50** by lock ring **54**. Seals **44** and **46** also seal the hanger **40** to wellhead **50**. Those skilled in the art will appreciate that one or more seals can be used and they can be mounted in the wellhead **50** instead of or in addition to the hanger **40**.

Figure 7 shows the running tool **12** released at thread **14** and pulled out of the well. In its place a tubing head adapter **62** is installed. Alternatively other equipment could be installed depending on the nature of the string **10** being run into the well.

Figure 8 is an alternative embodiment to Figure 1 and is identical except that it features a hydraulic cylinder **64** mounted to the running tool **12** with the capability of stroking a piston **66** to selectively slide sleeve **52** along the running tool **12** for reasons that will be explained below. Mechanical equivalents such as a rack and pinion are also contemplated.

As before, the string **10** is shown inserted into the wellhead **50** to allow the operation of a downhole tool or to secure the lower end of the string **10** to a seal bore or some other anchor (not shown). Securing the lower end of the string **10** allows for tension to be pulled on it.

Figure 10 shows the tension applied to the running tool **12**, which extends the string **10** and moves up inner sleeve **16** and dog **20** along with ratchet rack **36**. With the tension applied to running tool **12**, piston **66** is stroked to move down hanger **40** until its contact surface **58** engages shoulder **60** in wellhead **50**. Piston **66** can be stroked as the tension is being applied or before or after. Seals **44** and **46** are now in sealing engagement in the wellhead **50**.

Figure 11 shows the tension removed to allow dog **20** to engage ratchet rack **36** as previously described to hold in the applied tension. The running tool **12** is rotated to allow sleeve **52** to move away from locking ring **54** so it can spring out into groove **56** in wellhead **50**. The running tool can be removed after thread **14** is fully undone.

Thereafter, a tubing head adapter **62** or some other device depending on the nature of the string **10** is fitted to the wellhead **50**.

In either embodiment, the result is that in a single trip a tensile force is applied to the string **10** and the hanger **40** is placed in a sealing relationship to the wellhead **50** using seals **44** and **46**. In the same trip the hanger is locked in position with locking ring **54** or an equivalent structure. In the preferred embodiment of Figures 1-7 the act of sealing the hanger **40** is independent of locking it to wellhead **50**. These two operations can also be combined or one made dependent on the other. A separate trip to install a seal or locking device is eliminated.

The above description of the preferred embodiment is merely illustrative of the optimal way of practicing the invention and various modifications in form, size, material or placement of the components can be made within the scope of the invention defined by the claims below.